Orange responses to storage conditions and polyethylene wrapped liner

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Abstract: Extension of the citrus shelf life and storage period has attracted many researchers around the world. In this study, the effects of near ambient (14ºC and 67% RH) and refrigerated (5ºC and 85% RH) conditions and polyethylene wrapped liner were investigated on the water loss, firmness and deterioration of Iranian "Thompson" navel orange during 30 days storage period. At the end of 30 days storage, the orange cumulative weight losses in ambient and refrigerated conditions with polyethylene liner were 5.3% and 2.4%, and without polyethylene liner were 14% and 5%, respectively. The firmness decreased with increasing storage period. After 30 days, fruit from polyethylene liner treatment were 25% firmer compared with those without polyethylene wrapped liner. The visual appearance and marketability of orange fruits stored in the refrigerator and polyethylene wrapped liner was better than those stored at ambient condition and without liner.

Key words: orange, storage, weight loss, firmness, polyethylene liner

Citation: R. Tabatabaekoloor. 2012. Orange responses to storage conditions and polyethylene wrapped liner. Agric Eng Int: CIGR Journal, 14 (2): Manuscript No. 2036.

1 Introduction

Citrus is one of the most valuable horticultural crops in Iran. In 2010, the area sown with citrus was 2.6×10^5 ha and the total output was about 4.2 (Mt) (Ministry of Agriculture, 2010). This amount of output is much more than domestic needs, but the growing and marketing of fresh

Received date: 2012-02-03 **Accepted date:** 2012-04-09
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produce in Iran are complicated by postharvest losses both in terms of quantity and quality between harvest and consumption. The quality of fresh fruit depends on the postharvest handling during harvesting, transportation, and storage. Storage is one of the most important processes, because inadequate storage causes qualitative and quantitative fruit losses (Tefera, Seyoum and Woldetsadik, 2007).

In Iran, as a developing country, citrus fruits are handled, marketed and stored under ambient conditions with much less commercial storage in refrigerated conditions. The most important factors in maintaining quality and extending the storage and shelf-life of fruit, such as citrus, after harvesting are temperature and relative humidity. Postharvest water loss of fruits and vegetables results in fruit softening, and reduced shelf life (Smith et al., 2006). Application of proper storage practices is essential for maintaining high fruit quality. Maintenance of perishable produce commodities at optimum low temperatures is routinely used in the horticultural industry and has later been the focus of many scientific postharvest investigations over the years, including many of those conducted on citrus fruit (Schirra et al., 2004; Henriod, Gibberd and Treeby, 2005), but relatively few postharvest studies in citrus research have looked at the effect of relative humidity on fruit quality, particularly at low temperature and under prolonged storage conditions (Porat et al., 2004). " Shamouti " oranges stored at 5ºC and 98% RH in various polyethylene bag types showed an approximate five-fold reduction in moisture loss after 35 days (Ben Yehoshua et al., 2001). The commercial use of modified atmosphere packaging (MAP) technology and moisture control technology (MCT) grew markedly in recent years, particularly for use with highly perishable crops (Padilla-Zakour, Tandon and Wargo, 2004; Henriod, 2006). Creating and maintaining the optimum atmosphere to reach the benefit is based on packaging with plastic films known as modifies atmosphere packaging (Lee et al., 1996). In developing countries there are some limitations for using these technologies, but some types of liners like polymeric or polyethylene material are used to maintain the relative humidity in the enclosure of the container.

The current study evaluates the effects of polyethylene liner, ambient and refrigerated conditions on the water loss, firmness and deterioration of Iranian orange "Thompson" navel variety.

2 Materials and methods

"Thompson" navel as the most popular variety of orange (*citrus sinensis*) was got from orchards around the Khazar region, in Sari, Iran. Fruits were harvested by hand in December and without any process, in accord with common practice in the region, were placed into cartons with and without polyethylene liner. Each carton contains 50 hand picked oranges and 10 oranges randomly were selected and labelled by numbers. These samples were transported to the experiment site immediately after harvest and were stored under two different storage conditions, near ambient at 14ºC, 67% RH and cold store at 5ºC, 85% RH for 30 days. Weight of the fruit was measured with respect to storage period with electronic balance (Model GM1500P, Lutron Ltd, Taiwan).

In near ambient condition, the room relative humidity and temperature was controlled by a moisturizer with hygro-thermometer two channel temperature and RH data loggers (Model 750, Martoob Co, Ltd. Isfahan, Iran). The cold room was a commercial refrigerator with environmental control system. Data were collected every odd day for the water loss and visible deterioration for every package. Whole fruit firmness was measured on the first, fifteenth and last days by a hand-held penetrometer with a flat-end stainless steel probe. The probe consisted of a 6 mm diameter probe to measure tissue strength and turgor at a localized point. Four replicate compression tests were applied on opposite sides of the equatorial zone of each fruit. Data comprised the peak resistance force (N) displaced by the fruit and tissue during compression to a depth of 6 mm. Appearance and freshness of the fruit was evaluated by a well-trained group. It was based on rank from 1 to 5 in which 1 was for very bad and 5 for very good appearance, respectively. The

appearance checked every five days during storage. The SAS software was used for statistical analysis.

3 Results and discussion

3.1 Weight loss

The percentage cumulative weight loss of orange during storage under ambient and refrigerated conditions with and without polyethylene liner for 30 days of storage is presented in Figure 1 and Figure 2. The weight loss increased with storage period under ambient as well as refrigerated conditions. At the end of 30 days storage, the cumulative loss of weight in ambient and refrigerated storage conditions was 13.9% and 4.7% without polyethylene liner, respectively. Weight loss in ambient and refrigerated conditions was 5.3% and 2.4% with polyethylene liner, respectively. The fruit stored under ambient condition lost three and two times of weight compared to that stored in refrigerated condition. Also, the fruit stored under polyethylene wrapped liner lost two and a half and two times of weight compared to that stored without polyethylene liner. The trend in weight loss of orange fruits with storage period is in agreement with Singh and Reddy (2006) study. They reported that after 17 days storage, the orange fruit weight losses in ambient and refrigerated conditions were 19.4% and 7.3%, respectively.

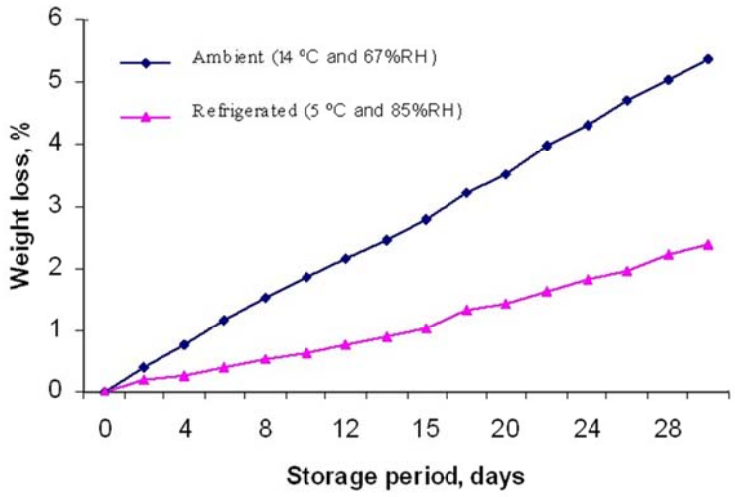

Figure 1 Weight loss of orange during storage under two different conditions with polyethylene wrapped liner

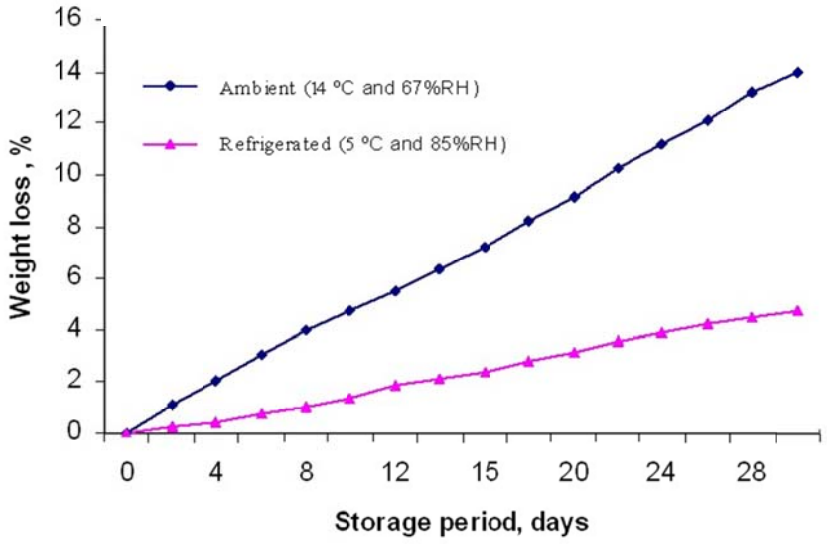

Figure 2 Weight loss of orange during storage under two different conditions without polyethylene wrapped liner

3.2 Firmness

Firmness decreased with storage period under refrigerated and ambient conditions (Table 1, Figure 3). The firmness of oranges was significantly higher for refrigerated oranges than for ambient ones after 15 and 30 days storage. Firmness of fruit with polyethylene liner decreased from 63 N in refrigerated to 54.1 N in ambient condition after 30 days. Also, Firmness of fruit without polyethylene liner decreased from 52.2 N in refrigerated to 44.1 N in ambient condition after 30 days. There was a significant difference in firmness between with and without polyethylene liner in refrigerated and ambient conditions, but the difference was not significant between without polyethylene wrapped liner and with liner in ambient condition. The decrease in firmness of orange fruit has strong relationship with storage period and firmness decreased with orange storage period (Singh and Reddy, 2006). Also, decreasing trend is in agreement with the results reported by Olmo, Nadas and Garcia (2000) for Valencia oranges.

Table 1 Treatments for two conditions with and without polyethylene liner with respect to the storage period

Treatment	storage period	Refrigerated condition		Ambient condition	
		With liner	Without liner	With liner	Without liner
Weight loss, %	**Day 0**	0	0	0	0
	Day 15	2.8	7.23	1.04	2.38
	Day 30	5.35	13.93	2.4	4.72
Firmness, N	**Day 0**	68.25	67.43	67.18	65.39
	Day 15	66.32	60.72	58.3	50.45
	Day 30	62.98	52.23	54.14	44.12
Appearance	**Day 0**	5	5	5	5
	Day 15	5	4	4	3
	Day 30	4	3	3	1

Note: (1) ANOVA for weight loss and firmness showed significant difference between columns 1 and 3 and 2 and 4 ($p \leq 0.05$)
(2) Appearance rank: 5; very good, 4; good, 3; average, 2; bad, and 1; very bad

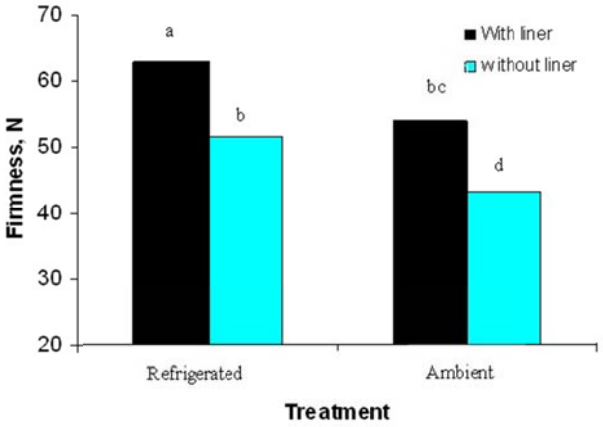

Figure 3 Firmness of orange at ambient (14ºC and 67% RH) and refrigerated (5 ºC and 85% RH) after 30 days storage period. Means were separated by using Duncan's multiple range tests ($P \leq 0.05$)

3.3 Appearance

According to Table 1 the appearance and firmness of oranges in refrigerated condition is much better than in ambient condition. On the other hand, if we use polyethylene liner the firmness and

appearance would be better than fruit without liner (Figure 4 and Figure 5). It is caused by the moisture conservation and reduction in weight loss. In ambient condition after 30 days storage, the fruit appearance was not good. Therefore, the appearance of fruit as the most important marketability and consumer attraction factor is preserved in the refrigerated condition and polyethylene wrapped liner.

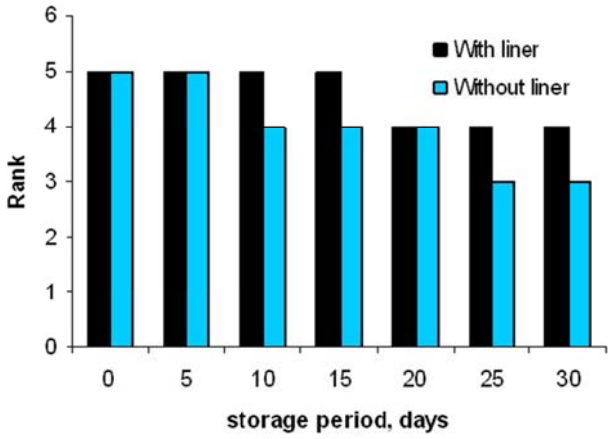

Figure 4 Fruit appearance during storage period at refrigerated condition

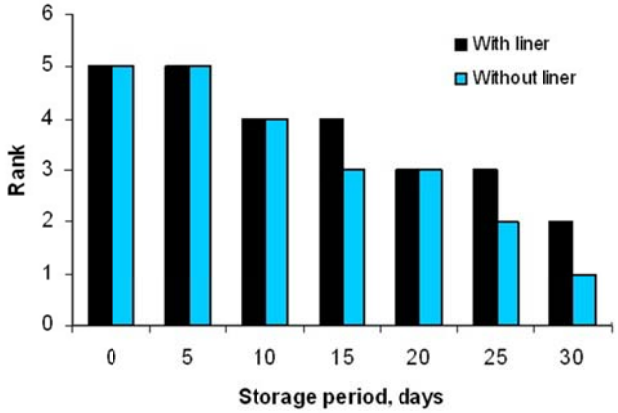

Figure 5 Fruit appearance during storage period at ambient condition

4 Conclusions

Storage condition affected the weight loss, firmness and appearance of Iranian "Thompson" navel orange during 30 days storage period. The weight loss increased with storage period under both ambient and refrigerated conditions. The weight loss in ambient condition was about 2 to 3

times compared to that stored in the refrigerated condition. Weight loss of fruits wrapped with polyethylene liner was less than those without liner in both conditions. The fruits stored in refrigerated condition were firmer than in ambient condition. Also, firmness of fruit wrapped in polyethylene liner was higher than those without liner. The appearance of oranges in refrigerated condition and polyethylene wrapped liner was much better than those stored in ambient condition and without polyethylene liner.

5 Acknowledgement

The author would like to thank the research council of Sari Agricultural Sciences and Natural Resources University for their financial support of this research.

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